

## CLAIMS

What is claimed is:

1. A method comprising:  
capturing multiple images of a target in an image sensing array (ISA)  
at different focal settings;  
analyzing over a plurality of the images an intensity of light at a pixel  
corresponding to a point on the target; and  
identifying one of a local maxima or minima of the intensity of light  
for the pixel to determine which image contains a substantially optimum  
focus for the pixel.
2. The method of claim 1 further comprising:  
determining a distance to a point on the target by analyzing the  
optimum focus for the pixel.
3. The method of claim 1 wherein identifying is performed local  
to the ISA.
4. The method of claim 2 wherein determining is performed  
local to the ISA.
5. The method of claim 1 further comprising:  
identifying a substantially optimum focus image for a plurality of  
pixels and assembling them into a composite image of substantially  
optimum focus.
6. The method of claim 1 further comprising:  
determining a distance to a corresponding point on the target for each  
of a plurality of pixels by analyzing the optimum focus for each pixel of the  
plurality and assembling the distances into a composite depth map.

7. The method of claim 5 further comprising:  
determining a distance to a corresponding point on the target for each of a plurality of pixels by analyzing the optimum focus for each pixel of the plurality and assembling the distances into a composite depth map; and  
assembling the composite image data with the composite depth map to form a composite data set containing both texture and depth data.
8. The method of claim 7 wherein forming the composite data set is performed local to an image capture device.
9. The method of claim 5 further comprising:  
incorporating the composite image into a three dimensional representation of the target.
10. The method of claim 6 further comprising creating a three dimensional representation of the target using the composite depth map.
11. The method of claim 5 further comprising:  
performing stereo correlation on the composite image and a second composite image to assemble a composite depth map.
12. The method of claim 1 wherein capturing at different focal settings comprises:  
moving at least one of an image sensing array (ISA) and a lens with a piezo actuator.
13. The method of claim 1 wherein capturing at different focal settings comprises:  
selecting at least one of a plurality of distinct image sensing arrays (ISAs) and lenses at different focal distances.
14. The method of claim 1 wherein capturing at different focal settings comprises:  
using an ISA capable of concurrently focusing at different depths within its structure.

15. The method of claim 1 wherein the optimum focus can be determined for a target surface that appears substantially homogeneous unless captured at finer than 300 pixels per inch resolution as measured at the target surface.

16. The method of claim 1 wherein the optimum focus can be determined for a target surface that appears substantially homogeneous to an unaided human eye.

17. An apparatus comprising an imaging device capable of concurrently capturing multiple images of a same target at discrete focal ranges.

18. The apparatus of claim 17 wherein the imaging device comprises multiple image sensing arrays (ISAs) arranged at different focal distances coupled to an optical system that distributes the same target view to each ISA.

19. The apparatus of claim 17 wherein the imaging device comprises an image sensing array containing multiple image planes arranged at different focal distances, each of which can be read out individually.

20. An apparatus capable of three dimensional (3D) imaging from one vantage point independent of profilometry comprising:

a housing having a physical terminus;

an image sensing array (ISA); and

an optical element in optical communication with the ISA,

wherein all light received by the apparatus for 3D imaging and any light emitted by the apparatus for 3D imaging passes through a physical terminus of the instrument at which point a maximum separation between any two light rays used for 3D imaging does not exceed 2 inches.

21. The apparatus of claim 20 wherein a capture end further comprises:

an illumination source.

22. The apparatus of claim 20 wherein the optical element is one of a lens, a reflector, and a light guide.

23. The apparatus of claim 20 wherein three dimensional imaging is independent of time of flight of light reflected from the location to the image sensing array (ISA).

24. The apparatus of claim 20 wherein the three dimensional imaging is performed without requiring motion of the physical terminus of the apparatus.

25. The apparatus of claim 24 wherein the three dimensional imaging method is stereoscopy.

26. The apparatus of claim 20 further comprising a wireless data link.

27. The apparatus of claim 21 wherein the illumination source can vary an incident angle of light impinging on a target surface.

28. The apparatus of claim 24 wherein the three dimensional imaging method performs captures of data from at least two points of view to a target.

29. The apparatus of claim 28 wherein at least two captures are performed sequentially by a same ISA.

30. The apparatus of claim 20 further comprising a controller to automatically vary an optical path of the light rays used to capture a three dimensional image.

31. The apparatus of claim 20 further comprising a display to visualize the data collected.

32. The apparatus of claim 31 wherein visualized data guides a user in the capture of a target surface.

33. The apparatus of claim 20 wherein the 3D image can be made of a target surface that appears substantially homogeneous unless captured at finer than 300 pixels per inch resolution as measured at the target surface.

34. The apparatus of claim 20 wherein the 3D image can be made of a target surface that appears substantially homogeneous to an unaided human eye.

35. A method comprising:  
illuminating a target with at least one emitter;  
capturing a first intensity of reflected light from the target with at least one detector, the path of the reflected light from the emitter to the detector constituting an optical path length;  
capturing a second intensity at a different optical path length; and  
determining a distance to the target based on the first and second intensity.

36. The method of claim 35 further comprising:  
varying the optical path length by at least one of: selecting a different emitter, selecting a different detector, moving an emitter, moving a detector, and altering an optical element in the optical path.

37. The method of claim 35 further comprising:  
creating a three dimensional representation of at least a portion of the target.

38. The method of claim 35 wherein illuminating comprises:  
pulsing the emitter at high frequency to differentiate from ambient illumination.

39. A method comprising:  
obtaining a first image of a surface of a target;

obtaining a second image including a portion of the same surface at a higher surface pixel density; and

aligning the first and second image based on the content of each image, and without requiring other position reference information.

40. The method of claim 39 wherein at least one of the images is a two dimensional image.

41. The method of claim 39 wherein at least one of the images is a three dimensional image.

42. The method of claim 39 further comprising aligning a third image with at least one of the second or first images wherein the third image includes a different portion of the first image.

43. The method of claim 39 wherein the aligning assembles a three dimensional representation of at least a portion of the target.

44. The method of claim 39 wherein the two images are captured at the same time.

45. The method of claim 39 wherein the two images are captured by at least two zones of a single image sensing array.

46. A method comprising:

obtaining a first image of a first portion of a surface of a target using a capture device;

obtaining a second image of a second portion of a surface of the target using the capture device;

monitoring the motion of the capture device relative to the target between the first and second image captures; and

aligning the first and second image based on the motion monitoring information.

47. The method of claim 46 wherein monitoring comprises:  
determining relative motion based on optically discernable features  
on the target surface.

48. The method of claim 46 wherein the monitoring comprises:  
determining relative motion of the capture device by observing  
accelerations of the capture device.

49. The method of claim 46 wherein aligning assembles a three  
dimensional representation of at least a portion of the target.

50. The method of claim 47 wherein a subset of the features is only  
optically discernable when captured at finer than 300 pixels per inch  
resolution as measured at the target surface.

51. The method of claim 47 wherein a subset of the features is not  
discernable to an unaided human eye.

52. A method comprising:  
capturing a first image of a first portion of a surface of a target using a  
capture device;  
capturing a second image of a second portion of a surface of the target  
using the capture device;  
moving the capture device relative to the target using a powered  
positioning device between capturing the first and second image;  
aligning the first and second image based on the known position of  
capture device; and  
determining a position for an adjacent capture based upon data  
known from at least one prior image.

53. The method of claim 52 wherein the capture device  
automatically acquires at least a portion of the target surface by determining  
a series of adjacent captures.

54. The method of claim 52 wherein the capture device is capable of capturing three dimensional range data.

55. An apparatus comprising:  
a handheld probe for noncontact three dimensional digitizing, to provide feedback during capture local to the probe to guide a user in positioning the probe to capture the target surface.

56. The apparatus of claim 55 further comprising a wireless data link.

57. The apparatus of claim 55 wherein the handheld probe further comprises a display to visualize the data collected.

58. An apparatus comprising:  
a handheld probe for noncontact three dimensional digitizing, to provide feedback during capture local to the probe to guide a user in positioning the probe to capture the target surface while allowing the user to look at one of the target and probe.

59. The apparatus of claim 58 further comprising a wireless data link.

60. The apparatus of claim 58 wherein the handheld probe further comprises a display to visualize the data collected.